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Cognition and Stress between Groups of Drinkers and Amounts of Exercise

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Abstract

Alcohol use is a crucial public health issue that has serious consequences for individual cognitive function. Stress is often cited as a risk factor for heavy drinking. Exercise has been examined as a method of decreasing alcohol use, increasing cognitive function, and decreasing stress. In this study, it was expected that heavy drinkers would experience higher perceived stress and would score worse on measures of cognitive function than light drinkers. It was also expected that exercise status would moderate the relationship between drinking and negative consequences, such that heavy drinkers who exercise would not experience as many negative consequences of stress and cognition as would heavy drinkers who do not exercise. The sample consisted of 20 relatively inactive adults that were asked about exercise, stress and drinking. The results suggested that there were significant differences in the cognitive functions of drinkers.

Exercise, Drinking, Stress and Cognitive Function

Alcohol use disorders are one of the major public health problems in the United States today. Each year roughly 26,000 people die from alcohol-related problems, like alcohol induced liver disease and alcohol induced deaths (Hoyert, & Xu, 2012). Further, there were 45,000 people killed in alcohol-related automobile accidents in 2009 alone (U.S. Census Bureau, 2012). It is estimated that the lifetime and 12-month rates will be about 17.8% and 4.7% for alcohol abuse and 12.5% and 3.8% for alcohol dependence (Hasin, Stinson, Ogburn, & Grant, 2007). *The Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition, Text Revision (*DSM-IV-TR*) defines alcohol use dependence as maladaptive patterns of drinking that result in impairment of daily functions and distress (APA, 2000).

Alcohol use disorders have many deleterious effects on people's physical health, mental health and neurocognitive function. Heavy alcohol use has been linked to cirrhosis of the liver (Smith et al., 2006) as well as breast, liver, pharyngeal, laryngeal, esophageal, and oral cancers (Chen, Rosner, Hankinson, Colditz, &Willet, 2011; Boffetta, & Hashibe, 2006). Alcohol use and abuse has also been seen to be highly comorbid with depression and anxiety (Almeida-Filho et al., 2007). Further, chronic long-term heavy alcohol use has been linked to brain damage, impaired memory, and Korsakoff's syndrome (Labudda, Von Rothkirch, Pawlikowski, Laier, & Brand, 2010). Research suggests that alcohol use has a substantial impact on cognitive function (Giancola, & Moss, 1998). Long-term heavy alcohol use has also been seen to have an effect on executive functioning including cognitive abilities like control of attention, cognitive flexibility, goal setting, specific aspects of information processing, and the control of

information in goal directed actions (Willoughby, Blair, Wirth, & Greenberg, 2012). For example, Blume, Marlatt, and Schmaling, (2000) asked 50 problem drinkers to complete a series of cognitive tests to investigate their executive function. The researchers hypothesized that the poorly operating executive function often seen in heavy drinking college students might interfere with their ability to recognize consequences that may be associated with drinking. Results suggested that greater perceived consequences from drinking and better short-term memory functioning were significantly associated with student's awareness of their drinking problems. Alcohol affects short-term memory and this study suggests that a better short–term memory was a predictor of the student's awareness of their drinking problem. Thus it is important to intervene before alcohol can do lasting damage to the person's executive cognitive functions.

Another factor that has been correlated with increased amounts of alcohol use is stress. In a study done by Park, Armeli, and Tennen (2004) a group of college student's drinking amounts were evaluated over a 28-day span with daily surveys. The findings from this study suggested that on days where the events that occurred were perceived as more stressful the students typically consumed more alcohol. This study suggests that students will use alcohol as a coping mechanism to deal with the elevated levels of stress that they may encounter due to school, social lives and relationships.

Research is needed to develop ways to improve and perhaps restore the executive function of heavy drinkers, as well as to combat the problems that lead to alcohol abuse in the first place (e.g., stress). A promising strategy that has the potential to help solve both of these problems is exercise. Exercise has been defined as any bodily movement done to maintain different aspects of physical fitness (Caspersen, Powell, & Christenson,

1985). Research suggests that exercise not only produces antidepressant effects and anxiolytic effects, but it also reduces a person's sensitivity to stress (Salmon, 2001). Based on the research conducted by Salmon (2001) suggesting that exercise has beneficial effects on depression, anxiety and stress, exercise may be a good intervention in college age students to help prevent higher quantities of alcohol use due to stress.

Physical activity and exercise research within the substance use domain has shown promising effects on helping smokers manage the cravings and withdrawals associated with quitting smoking cigarettes (Taylor, Ussher, & Faulkner, 2007). Exercise is relatively cost effective, time-flexible, and gives people the ability to engage in the intervention (i.e., exercise) independently. This is made easier by the accessibility of exercise and the availability of DVDs and videotapes that lay out exercise plans (Brown et al., 2009). Additional benefits of exercise have been seen within populations experiencing depression, anxiety, eating disorders, and importantly for the purposes of the current research, stress (Strohle, 2009; Stathopoulou, Powers, Berry, Smits, & Otto, 2006). In addition to its potential to reduce cravings associated with substance use and improve coping with the stress that can lead to substance use, exercise has also shown benefits like reducing the risk of developing a primary cancer, as well as preventing heart disease (Courneya, & Friedenreich, 2007; Morris, Everitt, Pollard, Chave, & Semmence, 1980).

Several studies have aimed to elucidate the effects of exercise on substance abuse. Correia et al., (2005) investigated the efficacy of exercise in decreasing substance use (primarily marijuana and alcohol) in a population of college undergraduates. The results found physical exercise to be successful at decreasing substance use within this

population. A recent study conducted by Brown et al., (2009) suggests that exercise reduces drinking among alcohol dependent individuals, however this study was limited by a small sample size of only 19 participants. In a study by Sinyor, Brown, Rostant, and Seraganian (1982), 58 residents at an inpatient alcoholism treatment center were put through an exercise intervention to assess the treatment effects of exercise. Participants were assigned to do one hour of aerobic exercise, five days a week for six weeks. At the end of the study, participants saw an increase in fitness at a level comparable to what is expected in non-alcoholics. Most importantly, the participants' abstinence rate was 69.3%, compared to the 38% abstinence rates for inpatients who did not receive the exercise program, and 36.9% for residents of a separate treatment facility. Even though this study demonstrated the potential effectiveness of exercise in increasing abstinence rates, it did have methodological flaws. One flaw of this study was a relatively small sample size (n=58). More important, however, was the lack of random assignment to treatment condition, which seriously limits internal validity.

A noteworthy study by Murphy, Pagano, and Marlatt (1986) examined the efficacy of exercise to decrease alcohol consumption among college students. This study included 60 male students between the ages of 21 and 30 who were considered heavy social drinkers and assigned them to three different conditions. The conditions were running, meditation, and a control group that received no treatment at all; each intervention lasted for eight weeks. Throughout the study, participants were asked to measure and record their own alcohol consumption. At the beginning of the study all three groups were consuming similar amounts of alcohol. During the six-week follow up period, participants in the exercise condition had significantly lower rates of alcohol

consumption than participants in the other two conditions. This study illustrates the effectiveness of exercise in reducing alcohol consumption among college drinkers when compared to a group of non-exercising drinkers. This study is limited by its small sample size of only 60 college students, thus it may be difficult to generalize these findings to a broader population. Further research is needed to determine the role that exercise may play in reducing drinking in alcohol dependent individuals.

Although studies have examined the effects of exercise on the reduction of drinking, these studies have not examined what the *mechanism* of the effects of exercise on drinking might be. What is it that exercise is doing that helps people to better regulate their drinking behavior? This study is guided by the idea that differing levels of drinking and exercise may have effects on levels of stress as well as cognitive function. Exercise may have a direct positive effect on self-regulation networks in the brain—perhaps even restoring damaged executive functions—that lead to reductions in problem drinking. There is some animal research that suggests animals that have access to exercise equipment demonstrate increases in neuronal growth in the dentate gyrus the area associated with memory (Vaynman, & Gomez-Pinilla, 2006). This finding suggests that exercise may be beneficial for the areas of the brain that deal with cognitive function. Much of the literature that has been published on the effects of exercise on the brain has dealt exclusively with cognitive decline in elderly populations. This research has shown significant relationships between physical activity and improved cognitive function in both healthy adults and adults with early signs of Alzheimer's disease (Colcombe, & Kramer, 2003; Etnier, Nowell, Landers, & Sibley, 2006; Heyn, Abreu, & Ottenbacher, 2004). Very little research has investigated the effects of exercise on the brain in young

adult samples (Hillman, Erickson, & Kramer, 2009), an area that is crucial for obtaining a better understanding of the effects of heavy alcohol use, due to the heavy alcohol use associated with this age group (Dawson et al., 2004).

Future research aiming to understand the effects of exercise on heavy alcohol use should take several factors into consideration. At this time, the benefits from exercise that have been seen in substance using populations are primarily correlational and therefore are tenuous at best. There is little known about how exercise will impact neurocognitive function in a sample of current drinkers. Exercise has been associated with beneficial effects in older populations (Colcombe, & Kramer, 2003; Etnier et al., 2006; Heyn, Abreu, & Ottenbacher, 2004), however it is not known how exercise will effect the cognitive functions of heavy drinking young adults. Exercise has also associated with reductions in stress (Salmon, 2001), however more research needs to be done to investigate if stress causes drinking, or if problem drinking causes stress and how exercise may mitigate the deleterious effects of both circumstances.

My Study

Substance use literature suggests that exercise may be related to decreased consumption of alcohol in populations who struggle with alcohol use disorders. People with alcohol use disorders have been seen to have problems in cognitive areas such as short-term memory, attention, and concentration. Further, the literature suggests that people who exercise have improved cognitive function, however much of this research has been based in older samples. Despite the prior research that has been done in the areas of both exercise and alcohol, there are several critical gaps in current knowledge.

The current study aims to make a correlation between drinking and exercise and

levels of stress and cognitive function between groups of heavy and light drinkers. The cognitive functions examined in this investigation include short-term memory, attention, concentration and other functions associated with the prefrontal cortex such as inhibition. Although prior research has investigated the effect of exercise on alcohol consumption, more research is needed to investigate whether higher levels of exercise are associated with better basic cognitive functions and stress levels in young adults. This study will investigate whether different levels of drinking (heavy or light) have an effect on stress and cognition. Secondly I will investigate if differing amounts of exercise impact baseline levels of stress in both drinkers and light drinkers. This finding would add to the literature by suggesting that exercise might serve to reduce stress among drinking populations (Strohle, 2009), which is a common complaint among many drinkers. I expect to see a main effect of drinking status (heavy or light) on stress and cognition, such that heavy drinkers will experience higher perceived stress and will score worse on measures of executive function. I also expect that exercise status will moderate the relationship between drinking and negative consequences, such that heavy drinkers who exercise will not experience as many negative consequences on stress and cognition as will heavy drinkers who do not exercise.

Method

Participants

The sample consisted of 20 sedentary adults (10 women, 10 men) recruited from the student and alumni population at the University of Colorado at Boulder. Eligible participants were between the ages of 18-28. For this study the average age of participants was 20.60 years old (*sd*=1.98), the youngest participant was 18 and the oldest

participant was 24. Participants were also required to be: a non-everyday smoker or tobacco user, free of any serious medical conditions or pregnancy, not on a restricted diet or diabetic, not on psychotropic medication, not on any medication for hypertension, hyperlipidemia, hypercholesterolemia, or hypoglycemia, and sedentary (i.e., could not have engaged in more than 60 minutes of weekly aerobic exercise consistently for the past three months). Additionally, the participants could not have used any illicit drugs in the past 60 days other than cannabis/marijuana, and could not have been receiving treatment for any kind of alcohol abuse or be in any programs such as alcoholics anonymous (AA). Participants were recruited for the drinking portion of this study based on the following criteria. To be considered as a heavy drinker, males had to consume five or more drinks in one sitting at least four days per week, while females were required to consume four or more drinks in one sitting four days per week. To be considered as a light drinker, both males and females could consumer no more than two or fewer drinks per month.

Measures

Cognitive Function Measures

Digit Span Task. This task, developed by Wechsler (1997), is a two-part task that asks the participant to repeat a series of digits both forwards and backwards. The forward Digit Span Task is meant to measure attention span and concentration (Conklin, Curtis, Katsanis, & Iacono, 2000). The backwards Digit Span Task is a better measure of working memory (Conklin et al., 2000). For both forwards and backwards trials there are two strings of digits of the same length the person must repeat. For example "5-8-2" and "6-9-4". Once the participant makes two errors in a row their digit span will be the span

they last repeated correctly. The Digit span task was incorporated in this study because in binge drinking individuals, tasks that involve working memory, attention, and concentration are seen to be impaired. Exercise has also been seen to help improve working memory, concentration and attention span in samples of older adults.

The Stroop Task used in this study consists of two forms: a "normal" form and an "interfering" form. In the normal form the participant will be required to say the color in which a word is printed as rapidly and accurately as possible. In the normal form, the ink color matches the color notated by the word, for example "blue" printed in blue. For the interfering form the participant is asked to name the ink color of a word independent of the written color name, which will always differ from the ink color, for example in response to the word "blue" printed in red ink they will have to respond "red". The words and ink colors will be blue, green, red, orange, purple and yellow. The Stroop Task measures participant's attention and ability to sort out meaningful information from distracting information and executive function. Exercise has been seen to improve these areas of cognitive function in aging samples (Heyn, Abreu, & Ottenbacher, 2004). Additionally heavy drinkers have been seen to be slower in the naming of color-name alcohol-related than light drinkers in an alcohol Stroop (Field, Christiansen, Cole & Goudie, 2007). In this study heavy drinkers also responded more slowly to the control stimuli in the Stroop than the light drinkers. This difference will be the focus in this study.

Self-report Assessments

The Perceived Stress Scale is a 14-item scale developed by Cohen, Kamarck, and Mermelstein (1983), (α=.618 in this sample). It measures the degree to which situations

in someone's life are perceived as stressful and all items are scored on a four point Likert Scale of "0" being Never and "4" being Very Often. A sample item is "In the last month, how often have you found yourself thinking about things that you have to accomplish?" Heavy drinking has been seen to be comorbid stress and many people drink because of daily stress and poor coping skills (Almeida-Filho et al., 2007). Prior research has shown that exercise reduces both anxiety and depression (Strohle, 2009).

Alcohol dependence spanning the last 3 months was assessed using the 10–item Alcohol Use Disorder Identification Test (AUDIT; Allen, Litten, Fertig, & Babor, 1997), (α=.816). The questions the AUDIT covers include things such as alcohol consumption, drinking behavior, adverse psychological reactions, and alcohol-related problems. Alcohol use problems were measured using the Rutgers Alcohol Problem Index (RAPI; White & Labouvie, 1989), (α=.927 in this sample). This measure was developed to measure alcohol related problems in adolescents. The RAPI correlates moderately with measures of alcohol quantity and frequency (White & Labouvie, 1989). The participants' current level of exercise was assessed with the Godin; this measure was developed by Godin and Shephard (1985). The Godin is a self-report assessment of the quantity, frequency, and intensity of exercise participation (Godin & Shephard, 1985).

Procedure

Participants were recruited using flyers placed around campus as well as in residence halls that allowed the posting of flyers and by a posting on Craigslist. Both the flyer and the Craigslist posting included a phone number for participants to call to obtain more information about the study. Interested participants called the CUChange lab and if the participant met the eligibility criteria, a research assistant (RA) would schedule a

baseline intake session at the CU Boulder Clinical and Translational Research Center (CTRC). Participants were classified as light drinkers or heavy drinkers based on their answers regarding their alcohol consumption. For their participation in all portions of the study participants were able to earn $90 and if they successfully completed all of their scheduled exercise sessions they were entered in a raffle where one participant wins $100.

Baseline. At the baseline session the participant completed a consent form. After completion of the consent form the participants received an examination by a CTRC physician and filled out a baseline questionnaire. At this time the participant completed a Blood Alcohol Content (BAC) test and was required to blow a 0.00 as well as complete a urine toxicology screen to test for illicit drug use other than cannabis or marijuana. At the baseline session the participant went through the baseline measures completing the AUDIT, RAPI, Godin and the Perceived Stress Scale in Qualtrics. The participant at this time engaged in a test of maximal aerobic exercise capacity or a "VO2 max". Once the VO2 Max test was complete, participants were given their exercise prescriptions. At this time the participants were paid $20.

fMRI session At this time, the participant were asked to recall their past seven days of physical activity with the Physical Activity Recall (Blair et al., 1985) as well as to complete a Timeline Follow-Back (Sobell, Maisto, Sobell, & Cooper, 1979). At this scan session the participants completed the Stroop Task on *cognitivefun.net* and the RA administered the Digit Span Task.

Research Design

This study was a cross-sectional study measuring psychological and cognitive function between groups of heavy and light drinkers as well as current physical activity

levels at the baseline time point. The independent variables in this study were drinking status (heavy versus light) and current level of physical activity. The dependent variables in this study were the participant's scores on the Stroop Task, the Digit Span Task, and their scores on the Perceived Stress Scale.

Results

The hypothesis stated that, there was an expected main effect of drinking status (heavy or light) on stress and cognition, such that heavy drinkers would experience higher perceived stress and would score worse on measures of executive function. It was also expected that exercise status would moderate the relationship between drinking and negative consequences, such that heavy drinkers who exercise would not experience as many negative consequences on stress and cognition as would heavy drinkers who do not exercise.

In the sample of participants of heavy and light drinkers the average age for heavy drinkers was 20.25 and for light drinkers the average age was 20.83. There were 4 males and 4 females in the heavy drinking group while there were 6 males and 6 females in the light drinking group. In the heavy drinking group the percent of participants that were white were 75% and in the light drinking group the percent of participants that were white was 50% (see table 1).

An independent-samples t-test was conducted to compare scores on the PSS between heavy and light drinkers. For the PSS there was no significant difference in the scores for heavy drinkers ($M = 23.63$, $sd = 4.24$) and light drinkers ($M = 24.42$, $sd = 5.99$) $t(18) = .332$, $p = .751$. These results suggest that there was no significant difference in levels of stress reported between light drinkers and heavy drinkers.

Independent-samples t-tests were conducted to compare scores on the AUDIT and RAPI between heavy and light drinkers. For the AUDIT there was a significant difference in the scores for heavy drinkers and light drinkers (see table 2). These results suggest that heavy drinkers were actually reporting significantly more alcohol consumption than the light drinkers. The results for the RAPI were very similar. There was a significant difference in the scores for heavy drinkers and light drinkers suggesting that heavy drinkers were reporting more problems due to alcohol use (see table 2).

Independent-samples t-tests were conducted to compare scores on the cognitive assessments for both heavy drinkers and light drinkers. For the forwards Digit Span there was a significant difference in scores for heavy drinkers and light drinkers (see table 3). This suggests that light drinkers had better attention span and concentration than heavy drinkers. There was a significant difference in the total Digit Span. For heavy drinkers and light drinkers (see table 3). There was a trend for a difference between heavy drinkers' and light drinkers' (see table 3) Stroop difference scores, suggesting that heavy drinkers actually experienced less decrement in performance as a result of interference. This finding was not significant, but warranted further examination given the direction of the finding. Interestingly, and contrary to hypotheses, the heavy drinkers performed *better* than light drinkers (see table 3) on the Stroop interference Task. This suggests that heavy drinkers were responding faster on interfering trials of the Stroop Task. This can be seen in the comparison of the scores on the Stroop interference when plotted against AUDIT scores for all of the participants (see Figure 1).

An independent-samples t-test was conducted to compare heavy drinkers' and light drinkers' amounts of exercise using the Godin. There was no significant difference

between heavy drinkers (M = 17.75, sd = 21.81) and light drinkers (M = 19.91, sd = 19.70) $t(18)$= .231, p = .820. Using a median split, the participants were split up into two groups based on their amount of exercise with those scoring 0 to 15 on the Godin in the "low exercise" group and those scoring 16 or more on the Godin in the "high exercise" group.

The hypotheses regarding the moderating effect of exercise on the relationship between drinking group and the dependent measures were tested with analyses of variance (ANOVAs) where the independent variables in each ANOVA were drinking status (light versus heavy), exercise status (low versus high) and their interaction.

Perceived Stress. There were no main effects of drinking group or exercise level on perceived stress, and there was no significant interaction.

Digit Span. The main effect of drinker group on the digit span task was marginal, (p = .056). There was no main effect of exercise level on digit span scores, and there was no drinker type by exercise level interaction (see Figure 2).

Digit Span – Forwards. The main effect of drinker group on the forwards Digit Span was marginal (p = .061). There was no significant effect of exercise level, and there was no drinker type by exercise amount interaction.

Digit Span – Backwards. There was a marginal main effect of drinker group on the backwards Digit Span score (p = .101). There was no main effect of exercise and no significant drinker type by exercise interaction.

Stroop Task. The main effect of drinker group on the Stroop Task was marginal, (p = .126). There was a marginal main effect (p = .115) of exercise level on Stroop Task scores, and there was no drinker type by exercise level interaction (see Figure 3).

Stroop – Normal Trials. The main effect of drinker group on the Stroop normal trials was not significant. There was a marginal main effect of exercise level ($p = .086$). There was no drinker type by exercise amount interaction.

Stroop – Interference Trials. There was a reliable main effect of drinker group on the Stroop interference trials ($p < .05$), suggesting that heavy drinkers had faster interference Stroop scores than light drinkers. There was a reliable main effect of exercise amount ($p < .05$), suggesting that those in the low exercise group had faster interference Stroop scores than high exercise amounts. The drinker type by exercise amount was not significant (see Figure 4).

Discussion

The hypothesis of this study was that there would be a significant negative effect of drinking status (heavy or light) on stress and cognition, such that heavy drinkers would experience higher perceived stress and would score worse on measures of executive function. It was also expected that exercise status would moderate the relationship between drinking and negative consequences, such that heavy drinkers who exercise would not experience as many negative consequences of stress and cognition as would heavy drinkers who do not exercise. The data collected during this study partially supported the hypothesis.

The data supported the portion of the hypothesis that suggested that heavy drinkers would have poorer cognitive function than their light drinking counter parts, as was suggested by Giancola and Moss (1998). The data suggested that heavy drinkers performed more poorly than light drinkers on the forward Digit Span and the Digit Span total. One outcome that was slightly unexpected was the fact that heavy drinkers

performed better on the Stroop Task than light drinkers on the Stroop difference measure (Stroop interference – Stroop normal). After examining the data both groups scored very similarly on the normal Stroop but the heavy drinkers were significantly faster on the interference trials. This was contrary to the hypothesis that heavy drinkers would have poorer cognitive processing. One possible explanation of this finding is that the light drinkers have better functioning brains, which might actually make them have greater interference. This is due to the fact that the Stroop is based on being able to inhibit your natural response to read the word (interference) and be able to decipher the color the word is printed in. It may be that this natural tendency to read the word (and have it interfere with processing the color) was functioning better among those with healthier brains. The heavy drinkers, on the other hand, may not have experienced as much interference because that natural tendency to read the word was not as strong. The cognitive functions of heavy drinkers that deal with reading may be inhibited, therefore they may have an easier time deciphering the color the word is printed in.

Limitations and Future Directions

There were several limitations of this study. The largest limitation was the sample size of only 20 participants. This is important because several of the results were almost significant but not quite significant ($p < .05$). Another limitation of this study was that it was a cross-sectional study, meaning that there is no definitive answer as to whether or not drinking is what affects cognition or if cognition affects drinking or if there was a confound that was not examined. To fix this an experiment would need to be run that would manipulate the independent variables. Another limitation of this study was that there was no measure of reading level. This is important because it is possible

that between the two groups the heavy drinkers may have had an overall lower reading level than the group of light drinkers. This could be an explanation of why their Stroop difference scores were smaller than those of the light drinking participants.

Another limitation was in the recruiting requirements. It was not an issue to find participants that met the criteria for heavy drinking or light drinking. However the levels of exercise that people could have prior to entering the study was. For this study the maximum amount of exercise that a person could participate in, in a week was no more than 60 minutes of moderate intensity exercise or greater. During recruiting we found that it was difficult to find participants that did not already exercise at that level or greater. In the future another research opportunity would be to run a study similar to this one but in a demographic that has more sedentary participants than college students in Boulder, Colorado.

One future direction that this research could go would be to examine adults who are considered heavy drinkers or light drinkers. This would be interesting because the heavy drinking adults most likely have been drinking longer than the typical heavy drinking college student. This would be interesting to examine because assuming that the adults have been drinking longer this would mean there has been a greater period for alcohol to have an effect on their cognitive function. It would be interesting to examine if the data that was seen in this study of heavy drinkers having lower cognitive scores would hold true for an older population. It would also be interesting to see if the differences that were seen were even greater due to the repeated and long-term use of alcohol or if these difference plateau around a certain age with a certain amount of alcohol use.

Additionally it would be interesting to conduct further research that would incorporate the Stroop Task in drinkers. This would be interesting to examine due to the findings that were contrary to the hypothesis that heavy drinkers had faster reaction times on the Stroop Interference. It would be interesting to examine further with a larger sample if the effects that were seen in this study were due to drinker status and cognitive levels. Or if there was a confound that could not be identified with the data that was collected.

The data for this study came from project NED. NED is set up as a three month long intervention study. Originally it had been planned to collect data at the baseline and follow-up appointments to examine the effect of increasing exercise on the dependent measures. However due to circumstances that were outside of my control I was not able to do that. NED is running once again and based on the data that was obtained from the baseline appointment in the future it would be interesting to make a comparison between heavy drinkers and light drinkers cognitive function especially on the Digit Span at baseline and at the follow-up appointment. It would be interesting to examine the data after an exercise intervention, due to research that has been conducted by (Colcombe, & Kramer, 2003; Etnier, Nowell, Landers, & Sibley, 2006; Heyn, Abreu, & Ottenbacher, 2004) that suggests that exercise can improve cognitive function.

Project NED also incorporates the use of fMRI. The possibility of examining cognitive function of heavy or light drinkers with functional scans during the MRI sessions was not explored. The possibility of examining any structural differences in the brains of heavy and light drinking college students was also not explored. These would both be interesting avenues to explore in the future.

Conclusions

The data in this study partially supported the hypothesis, such that heavy drinkers have poorer cognitive function than their light drinking counter parts, at least on portions of the Digit Span. Due to the limitations of this study, it is hard to make practical implications, however if some of the limitations were addressed then this study would provide very useful information on alcohol use and its effect on cognitive function. More specifically this research could one-day help combat the negative effects alcohol has on cognitive functions in populations that are abusing alcohol.

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Table 1

Heavy and Light Drinker Descriptive Statistics and Demographic Information

Drinker Type	Heavy Drinker	Light Drinker	Test for Difference
Age	$M = 20.25$, $sd = 1.75$	$M = 20.83$, $sd = 2.17$	t
Gender	Male = 4 Female = 4	Male = 6 Female = 6	χ^2
Percent White	75%	50%	χ^2

Table 2

Heavy and Light Drinker Scores on the AUDIT and RAPI

Drinker Type	Heavy Drinker	Light Drinker	Test for Difference
AUDIT	M = 12.75, sd=4.46	M = 3.92, sd=3.58	t = -4.9 p = .000
RAPI	M = 12.13, sd=10.23	M = .92, sd=1.78	t = -3.76 p = .001

Table 3

Heavy and Light Drinker Mean Scores on Cognitive Measures

Drinker Type	Heavy Drinker	Light Drinker	Test for Difference
Digit Span Forwards	$M = 7.38$, $sd = 2.19$	$M = 9.86$, $sd = 2.07$	$t = 2.26$ $p = .042$
Digit Span Backwards	$M = 6.62$, $sd = 3.48$	$M = 8.86$, $sd = 1.41$	$t = 1.67$ $p = .119$
Digit Span Total	$M = 14$, $sd = 5.12$	$M = 18.71$, $sd = 3.21$	$t = 2.17$ $p = .049$
Stroop Interfere (ms)	$M = 1466$, $sd = 280.01$	$M = 2004$, $sd = 653.44$	$t = 2.11$ $p = .057$
Stroop Normal (ms)	$M = 1165.13$, $sd = 331.98$	$M = 1280.86$, $sd = 407.12$	$t = .607$ $p = .554$
Stroop Difference (ms)	$M = 300.88$, $sd = 399.31$	$M = 646.33$, $sd = 401.66$	$t = 1.60$ $p = .136$

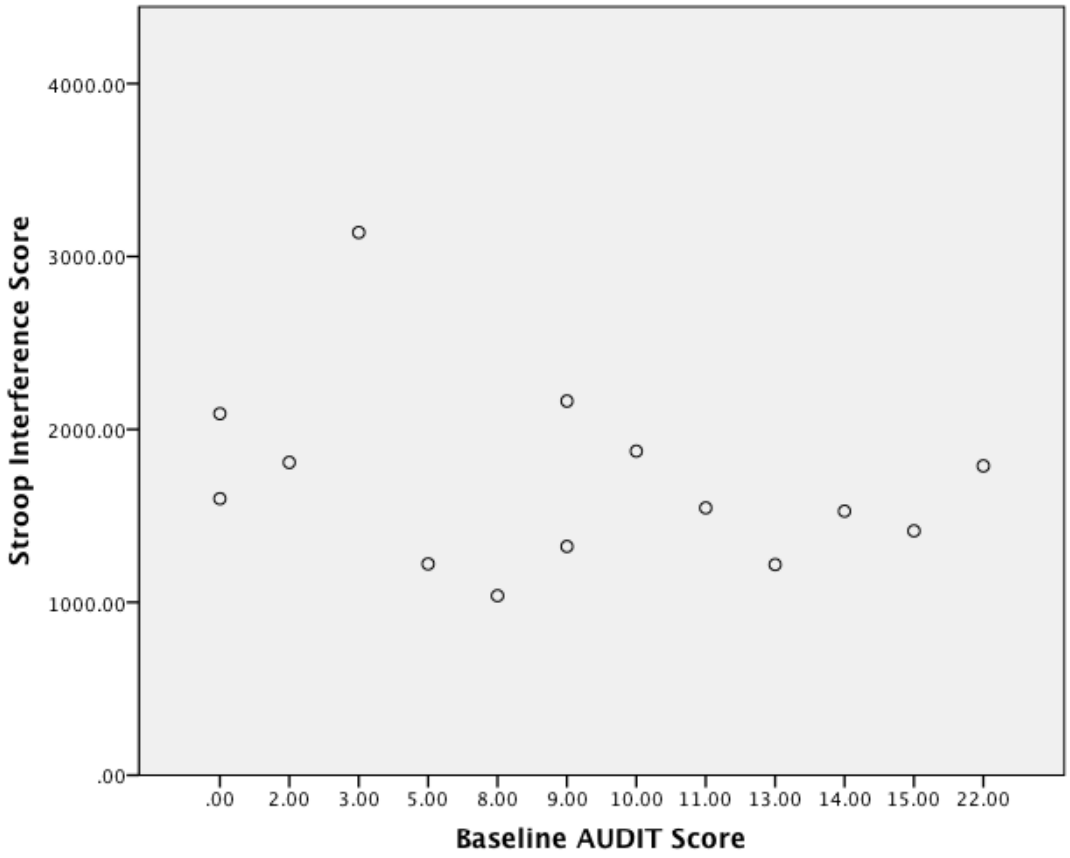

Figure 1. Baseline AUDIT Score Compared to Stroop Interference Score.

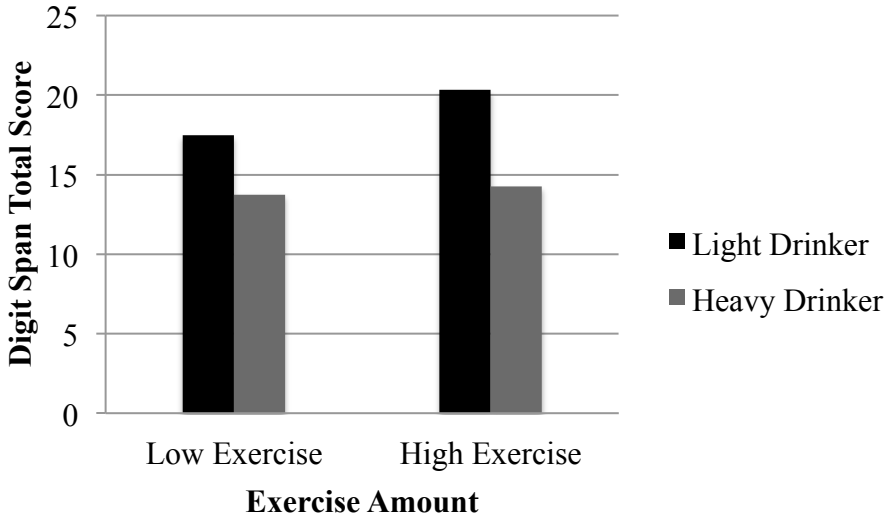

Figure 2. Relationship of drinking status and exercise level to scores on the Digit Span Total score.

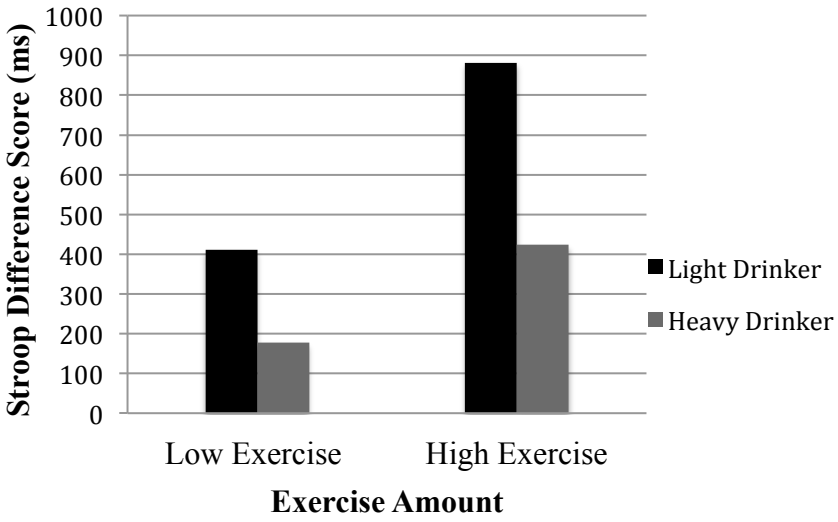

Figure 3. Relationship of drinking status and exercise level to scores on the Stroop Task.

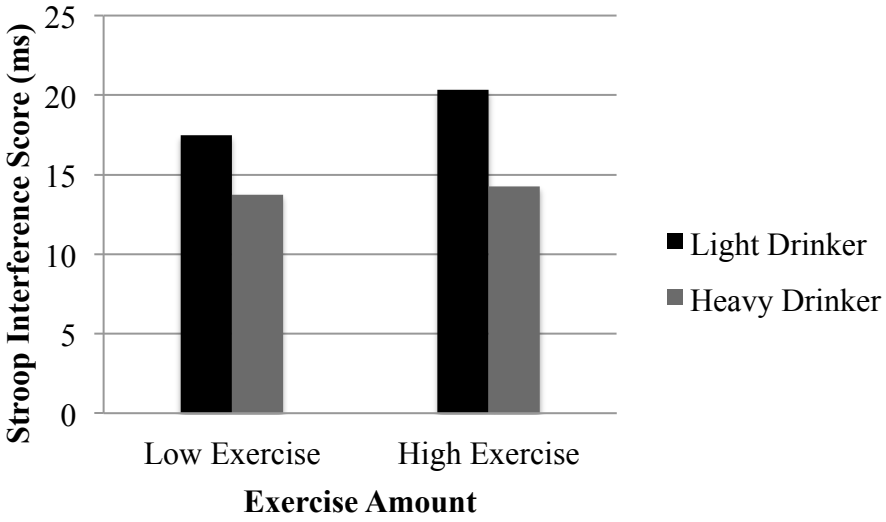

Figure 4. Relationship of drinking status and exercise level to scores on the Stroop Interference task.

Appendix A

Instructions: The questions in this scale ask you about your feelings and thoughts during the *last month*. In each case you, you will be asked to indicate *how often* you felt or thought a certain way. Although some of the questions are similar, there are differences between them and you should treat each one as a separate question. The best approach is to answer each question fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate. For each question choose from the following alternatives:

0. Never
1. Almost Never
2. Sometimes
3. Fairly Often
4. Very Often

In the **LAST MONTH:**

1. In the last month, how often have you been upset because of something that happened unexpectedly?

(0) Never

(1) Almost Never

(2) Sometimes

(3) Fairly Often

(4) Very Often

2. In the last month, how often have you felt that you were unable to control the important things in your life?

(0) Never

(1) Almost Never

(2) Sometimes

(3) Fairly Often

(4) Very Often

3. In the last month, how often have you felt nervous or "stressed"?

(0) Never

(1) Almost Never

(2) Sometimes

(3) Fairly Often

(4) Very Often

4. In the last month, how often have you dealt successfully with irritating life hassles? **(REVERSE SCORED)**

(0) Never

(1) Almost Never

(2) Sometimes

(3) Fairly Often

(4) Very Often

5. In the last month, how often have you felt that you were effectively coping with important changes that were occurring in your life? **(REVERSE SCORED)**

(0) Never

(1) Almost Never

(2) Sometimes

(3) Fairly Often

(4) Very Often

6. In the last month, how often have you felt confident in your ability to handle personal problems? **(REVERSE SCORED)**

(0) Never

(1) Almost Never

(2) Sometimes

(3) Fairly Often

(4) Very Often

7. In the last month, how often have you felt that things were going your way? **(REVERSE SCORED)**

(0) Never

(1) Almost Never

(2) Sometimes

(3) Fairly Often

(4) Very Often

8. In the last month, how often have you found that you could not cope with all the things you had to do?

(0) Never

(1) Almost Never

(2) Sometimes

(3) Fairly Often

(4) Very Often

9. In the last month, how often have you been able to control irritations in your life? **(REVERSE SCORED)**

(0) Never

(1) Almost Never

(2) Sometimes

(3) Fairly Often

(4) Very Often

10. In the last month, how often have you felt that you were on top of things? **(REVERSE SCORED)**

(0) Never

(1) Almost Never

(2) Sometimes

(3) Fairly Often

(4) Very Often

11. In the last month, how often have you been angered because of things that happened that were outside of your control?

(0) Never

(1) Almost Never

(2) Sometimes

(3) Fairly Often

(4) Very Often

12. In the last month, how often have you found yourself thinking about things that you have to accomplish?

(0) Never

(1) Almost Never

(2) Sometimes

(3) Fairly Often

(4) Very Often

13. In the last month, how often have you been able to control the way you spend your time? **(REVERSE SCORED)**

(0) Never

(1) Almost Never

(2) Sometimes

(3) Fairly Often

(4) Very Often

14. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

(0) Never

(1) Almost Never

(2) Sometimes

(3) Fairly Often

(4) Very Often